

Flying Unmanned Aircraft: A Pilot's Perspective

"It's not un-piloted..."



Mark Pestana
NASA Research Pilot
Dryden Flight Research Center,
Edwards AFB, CA

Presented to:
Human Factors Conference
California State University,
Long Beach, CA March 2012

Note: The information in this presentation is the author's and may not reflect official NASA policy

TOPICS

- **NASA MQ-9 *Ikhana* (Predator-B)**
- **Pilot – Vehicle Interface Design**
- **NASA RQ-4 Global Hawk**
- **Defining “Pilot” in the UAS world**
- **UAS Wildfire Geo-location Mission**

NASA MQ-9 *Ikhana*

Ikhana = Native American Choctaw word for...

“Intelligence”

“Learning”

“Awareness”



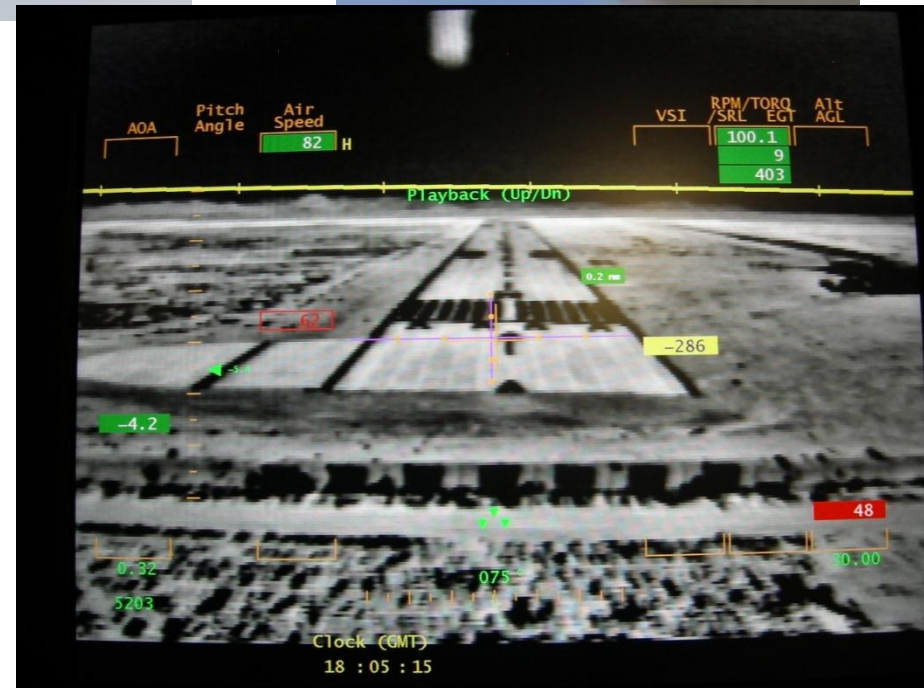
MQ-9 Reaper/ Predator-B



MQ-1 Predator -A



Two nose-mounted cameras: Color Visible & B&W Infrared



Initial power-up,
fueling, engine start,
and local area flying

C-Band
Line-of-sight antennas
and remote camera



Ground Control Station

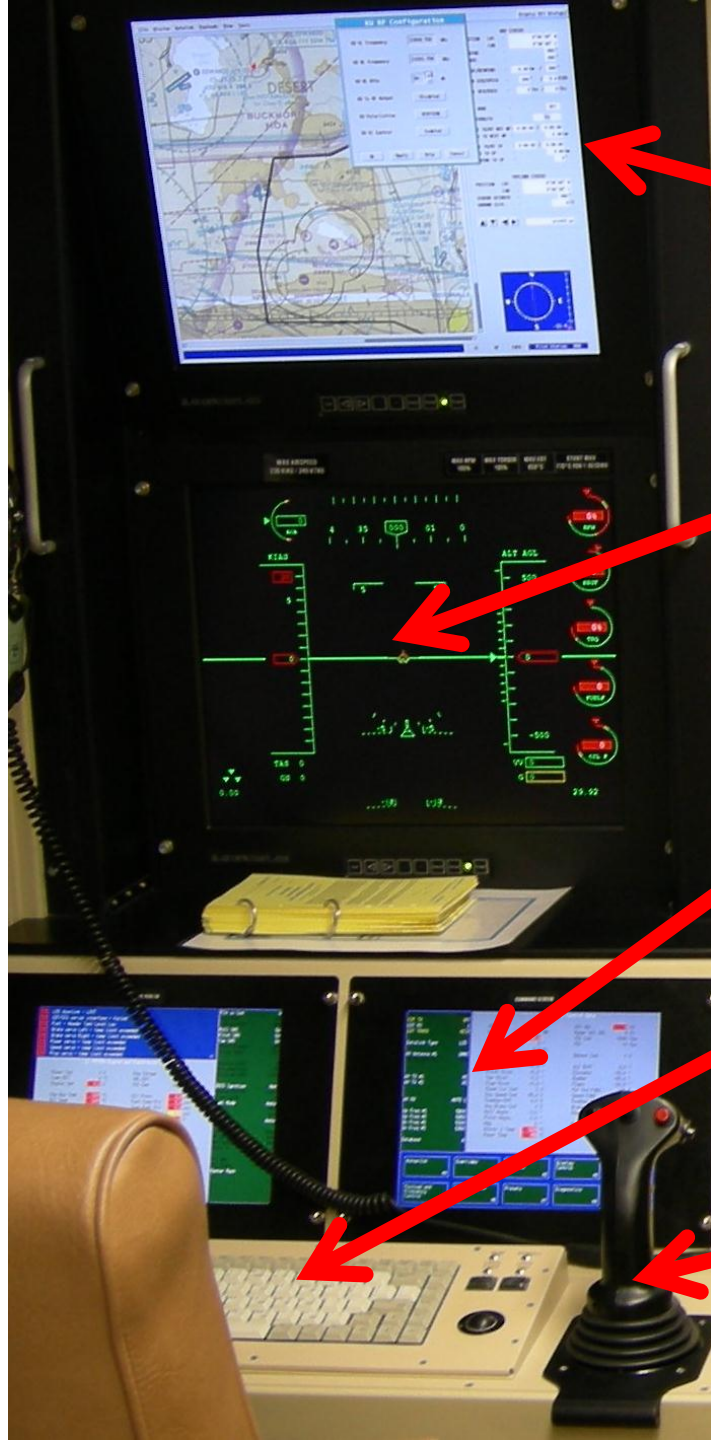
Over The Horizon
Long Range Link
Ku-bandSatCom



MQ-9 Ground Control Station (GCS)

Two Pilot Stations





**Tracker Display
Systems Menus**

Camera View with HUD

**Systems Displays
Systems Menus**

Keyboard / Trackball

**Control Stick,
Throttle, Flaps, Rudder Pedals**



Remote Camera

Provides situational awareness of people , equipment, and vehicle movement near aircraft.





Ground Control Station:
People talk
Phones ring
People come and go

Long-duration missions.
Multiple crews: Hand-overs



Fatigue
Boredom
Complacency
Shift work = “day sleepers”



So, what's it like to fly a UAS?

Well....What if you stepped into your cockpit...

...and you lost 4 of your 5 senses?

You only have *vision*!



Only 1 sense?

- You **can't hear** the engine rpm fluctuating
- You **can't feel** vibrations, accelerations or motion
- You **can't smell** the fuel leak
- You **can't taste** the electrical fire smoke
- AND, you **lose vision** in one eye, only 30° FOV!
- WELCOME to UAS flying!

With decades of evolving cockpit design, today's aircraft exhibit common standard control and display formats and arrangements.

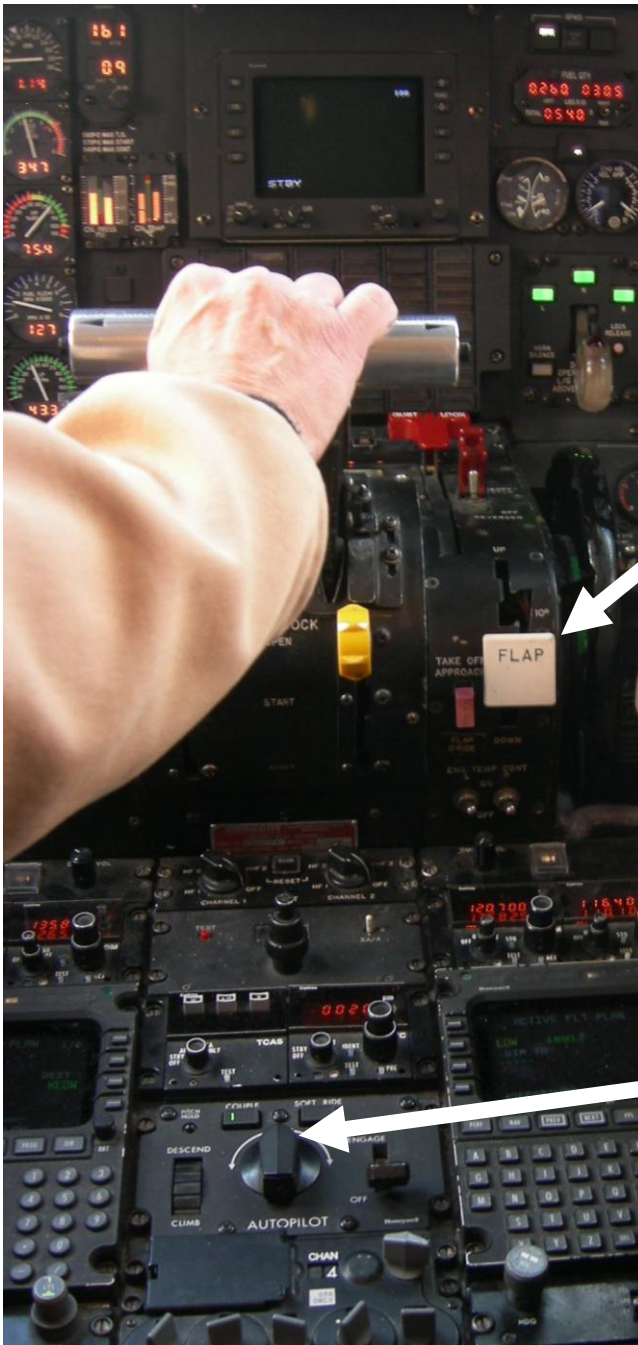
Example: The “T” arrangement
It works in many types, small and large.



Cessna 182



Boeing 737



**Use of the
Tactile sense**



**Different shapes of
actuators enable
the pilot to direct
attention
elsewhere...while
activating
systems.**



Digital Information



Unmanned Aircraft System Digital /Tabular Display Format

Example of Display and Control Issues

IFF Transponder “IDENT” Task

1. Remove right hand from control stick
2. Move cursor to tracker display
3. Click on TOOLS menu
4. Scroll to IFF
5. Click to open IFF window
6. Click “IDENT” button
7. Click “APPLY”

Accessed by trackball
and Left/Right buttons

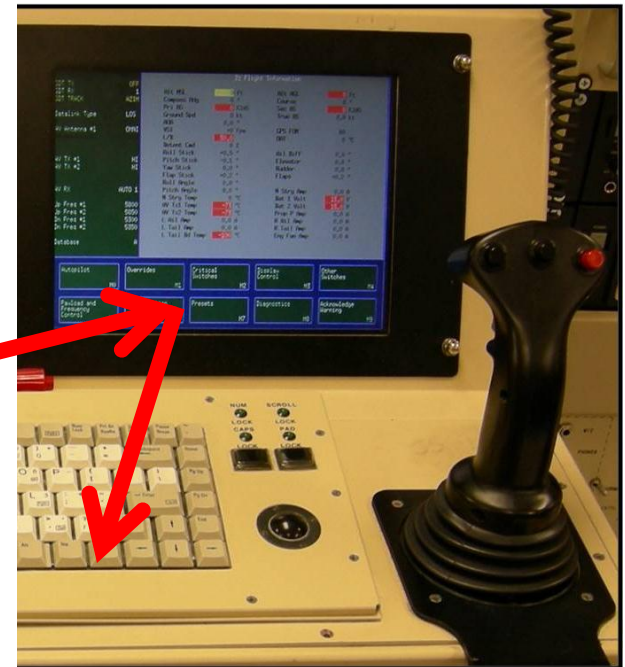


Example of control / display issues

Q: How do I TURN **ON**
the Fuel Heaters?

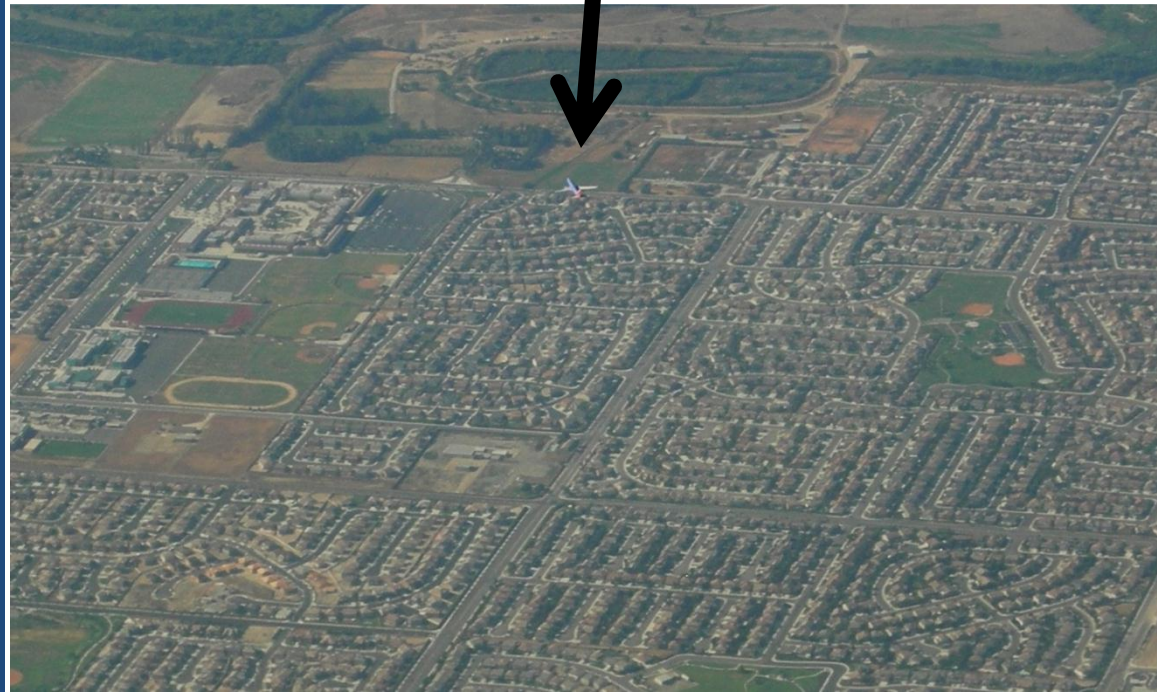
Fuel Heat Inhibit

Disable / Enable



“How far can you see a plane?”

Light
Contrast
Color
Texture
Distance
Motion
Shape
Reflectivity
Atmospheric Filtering
Weather
Acuity



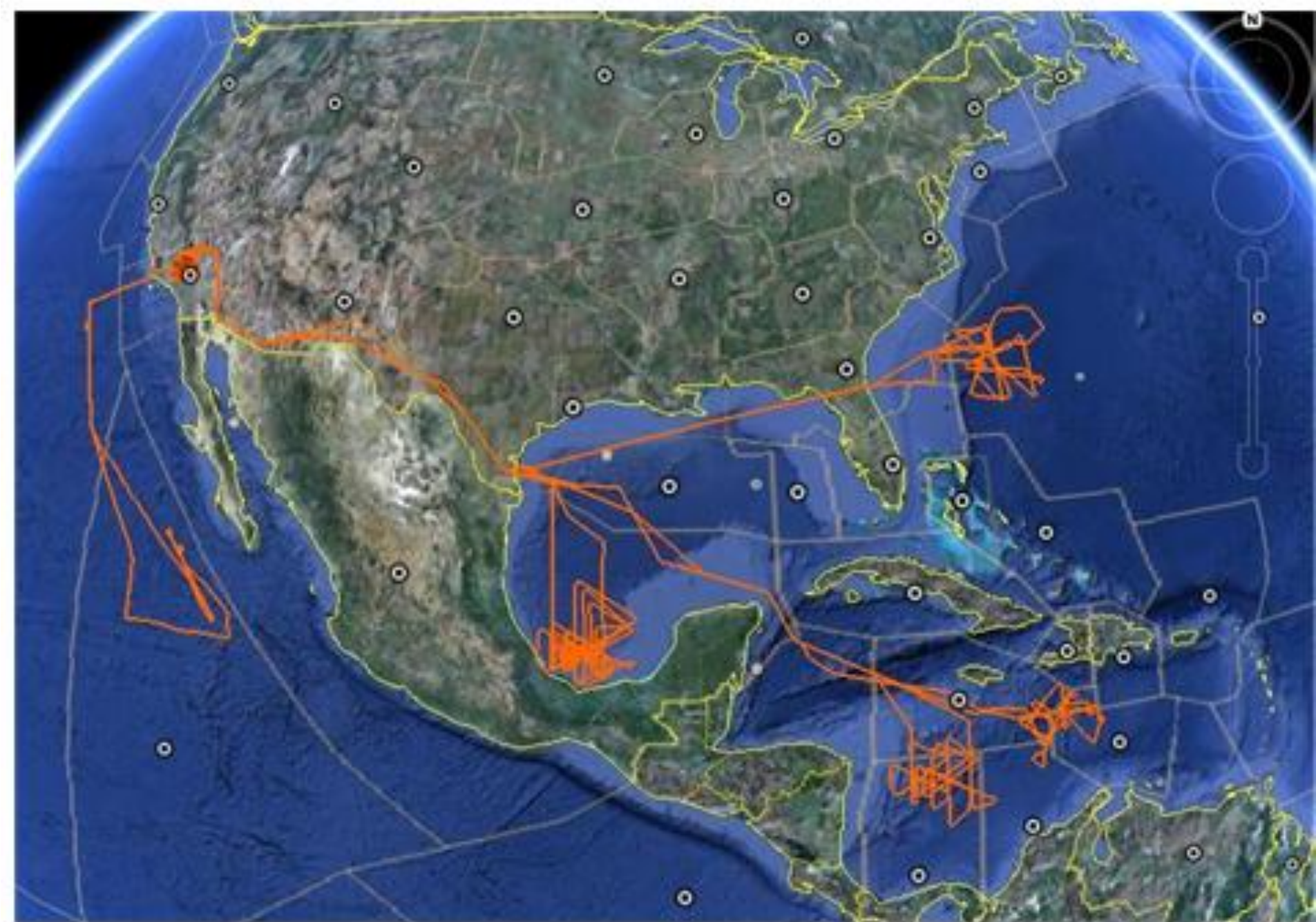
RQ-4 Global Hawk



Global Hawk Operation Center

The pilots fly with mouse and keyboard.





Q: What's a "pilot"?



TOYSBASE.COM

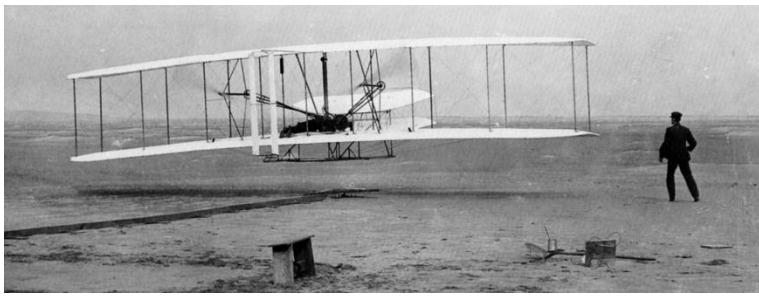


Samuel Clemens and his Pilot's Certificate

19th Century Pilot.

- Riverboat Captain
- Skills: River navigation, rudder control, soundings, shovel coal, supervisor...





20th Century Pilot

- Strapped to an airplane, direct interface to controls.
- Motor skills are primary metric of performance
- Increasing use of automation, systems management.





21st century pilot... "fly-by-wire"

- "Remotely" connected to the controls, systems management, monitor autonomous operations.
- **In some cases, motor skills have little/no relevance.**

Global Hawk cockpit:
Autonomous operations.
Mouse and keyboard controls.



What is a “pilot” ?

Knowledge, Ability, and Skill Sets

(relative relationships are not necessarily to scale)



Video Gamer



Radio Controlled
Visual Line-of-sight

Remotely
Piloted
Unmanned
Aircraft
System

Piloted
(manned)
Aircraft



What do these people
have in common?



What is a “pilot” ?

Knowledge, Ability, and Skill Sets

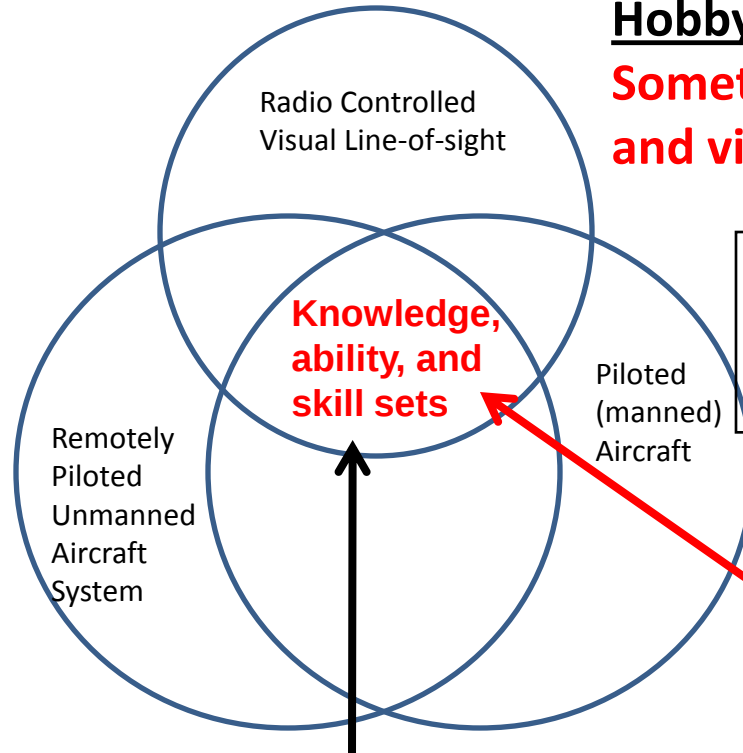
(relative relationships are not necessarily to scale)

Video Gamer
Reset Button

Model airplane
Hobbyist

**Sometimes...left is right,
and vice versa.**

UAV Pilot
**Skill sets depend on
control method**



Jet Jock
**Self-preservation
instincts.**

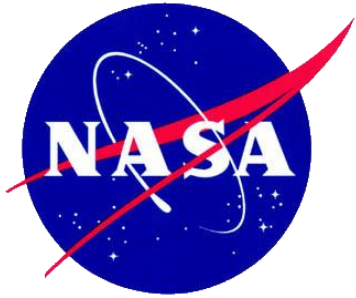
**Plus: Judgment,
experience,
flexibility, etc.**

Airmanship / Air Sense / Knowledge: Navigation; Communication protocols; FAA Airspace Rules, Requirements, and Regulations; Terminal area procedures, Weather forecasting and alternate airfield assessment, Mission planning, Emergency procedures, aircraft systems, principles of flight, etc.

Considerations

- Proven human-machine interface standards exist
 - use them / adapt to UAS as required.
- Extended duration missions and remote operations require new con-ops for multiple crews, circadian shift, etc.
- No single definition of “Pilot”
 - Hence: Training, qualification, currency, proficiency standards depend on the method of control, et al.
- Consider a future state, where multiple UAS are controlled by a single “operator”.
 - May blend the roles of pilot and air traffic controller.

Western States Fire Mission





Where is the exact location of fire lines and hot spots?



Where do you employ limited resources?
...and keep them Safe!



FAA Provisions...The COA

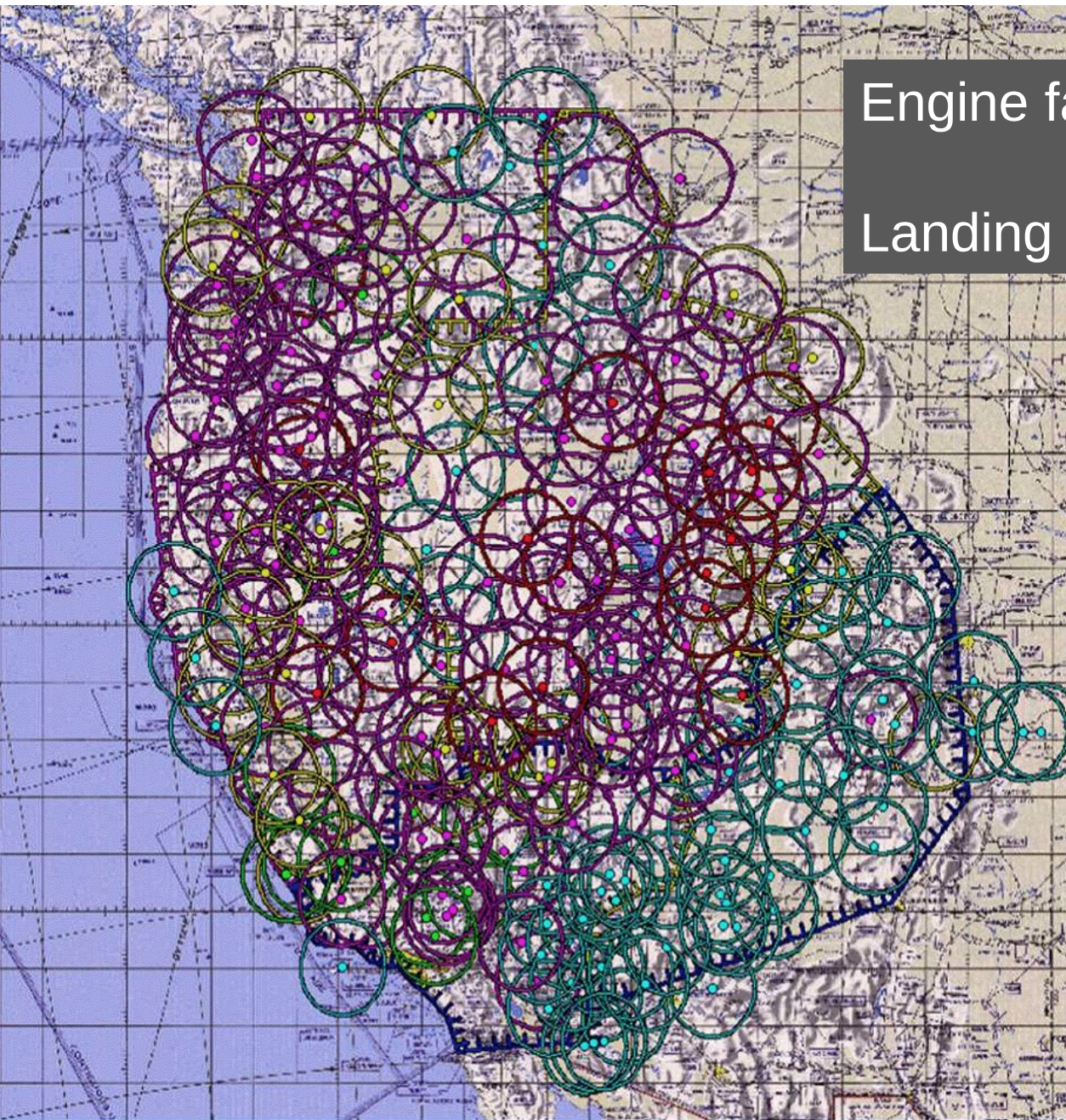
- **One assigned Flight Level (FL 230), in Class A airspace.**
- **-Two-way radio communication and transponder.**
- **- Climbs/descents while in Edwards AFB airspace.**
- **File flight plan 72 hrs prior, fly 1 of 3 “standardized” routes.**
- **Demonstrated “Lost Link” ability: Return via same route.**
- **Emergency landing sites: Military only.**
- **Designate “set-down sites” (fields, lakebeds) if engine failed.**
- **MQ-9 demonstrated reliability/capability/systems redundancy**

Approved landing sites for
a generator failure and
range limited by battery
life.



Engine failure glide range

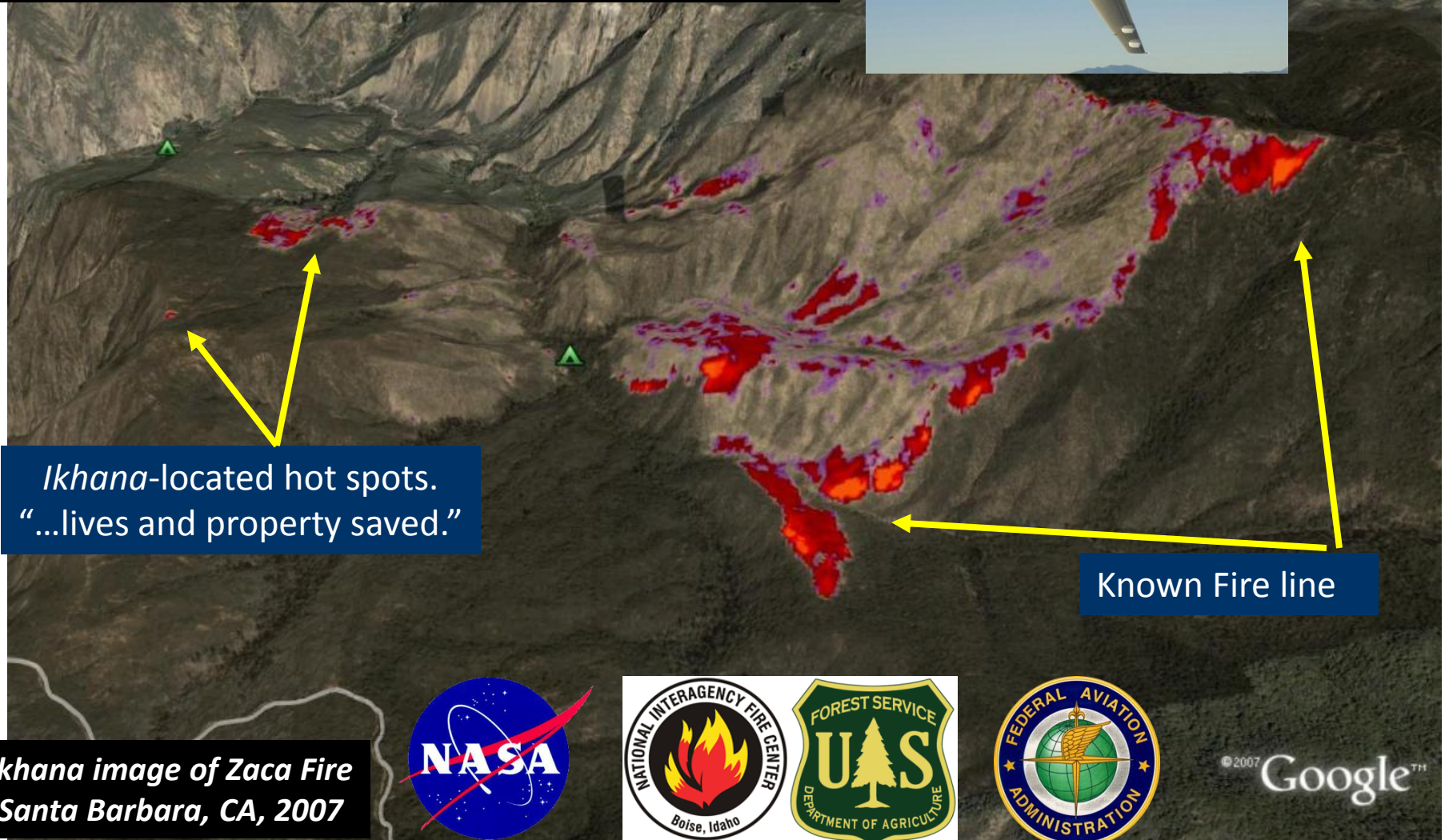
Landing sites



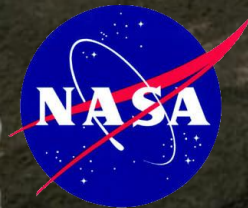
Four Tech Demonstration Missions



Ikhana Infrared Data and GPS locations are merged with 3-D Google Earth map/image. Transmitted to Fire Fighters in less than 10 minutes (vs. hours).



*Ikhana image of Zaca Fire
Santa Barbara, CA, 2007*



© 2007 Google™

Questions?

